

METHOD AND SYSTEM FOR PROVIDING COMMUNICATIONS SERVICES

Related Applications

This application is a continuation of Patent Application Serial No. 09/885,964,
entitled METHOD AND SYSTEM FOR MEDIATING INTERACTIVE SERVICES
OVER A WIRELESS COMMUNICATIONS NETWORK, filed June 22, 2001 and
further claims priority from Provisional Patent Application Serial No. 60/252,468,
entitled METHOD AND SYSTEM FOR PROVIDING INTERACTIVE SERVICES
OVER A WIRELESS COMMUNICATIONS NETWORK, filed November 22, 2000,
and Provisional Application Serial No. 60/283,377 entitled METHOD AND SYSTEM
FOR MEDIATING INTERACTIVE SERVICES OVER A WIRELESS
COMMUNICATIONS NETWORK, filed April 13, 2001, all of which are incorporated
by reference, as if fully set forth in their respective entireties herein.

Field of the Invention

The present invention relates generally to providing interactive services over a
communications network, and more particularly to a system and method for providing
interactive services via a wireless communications network.

Background of the Invention

On-line entertainment has been popular for several years. Users may connect to
a communications network, such as the global interconnection of computing devices

and networks commonly referred to as the Internet, using desktop computers and enjoy computer-hosted games ranging from simple board games, like backgammon, to more complex and graphic intensive adventure games for example. Developments in technology have enabled users to engage in multi-player, interactive gaming sessions with other users at remote locations. The ability to play a game with friends, and even strangers, who are not similarly located creates an exciting outlet for gaming aficionados.

It is desirable to provide interactive gaming, as well as other interactive applications, to users over wireless networks. Using a mobile handset as a gaming device for example, users may play games with other players not in their area without being tied down to their desktop computer. The thrill of interactive gaming coupled with the convenience of being able to play anywhere through a mobile handset makes wireless interactive gaming a very exciting, and potentially profitable, opportunity for operators of wireless networks.

Interactive gaming over a wireless network, however, is not without disadvantages. Latency and data transmission delays may create performance issues, e.g. may degrade performance, when gaming over any network, particularly over wireless communication networks. Latency issues may be attempted to be solved by offering only simplistic games with no or low quality graphics that are unaffected by communication delays. These systems, however, significantly depreciate the users' gaming experience. In addition, many known wireless interactive gaming systems are

not truly interactive. Many systems fail to adapt the state of play of the game based on the skill of the players, features of the users' access devices, or the users' connections to the network, potentially leaving some players at a significant disadvantage. Other known systems tax network capacity and waste network resources to such a degree that network operators must charge users prohibitively high service fees to avoid significant losses. Still other systems fail to mediate the environment on which the game is being played.

Although traditional gaming systems may claim to offer an enhanced, interactive gaming experience, they typically fail to offer a fully interactive real time gaming experience, with high resolution graphics, while efficiently using network resources, managing the game state for a level playing experience among users, and/or offering those services at a low, fixed, monthly service charge, that is not based on minutes of use, over a wireless network communications.

The present invention, in contrast, addresses the problem of how to deliver an enhanced, interactive game experience efficiently and cost effectively. In particular, the system and method of the present invention may offer a real-time, interactive experience and improve control of the transfer of game state information. In addition, the present invention may controls the game state for a level playing experience and control delivery of the interactive application to the user to optimize the utilization of limited network bandwidth, for example. This enables the operator to provide a more enhanced interactive gaming experience with the same amount of network resources.

This also creates the possibility of providing a wireless game service to end users at a flat monthly rate, rather than on a "per unit of time" basis. In this regard, the pricing model of Assignee's Cricket™ wireless telecommunications services may be adopted.

Brief Summary of the Invention

A method for providing interactive communications services to a plurality of users using a corresponding plurality of communications devices via a wireless network which may degrade performance of the communications services, the method including: initiating the communications services; requesting state information from at least two of the communications devices indicative of whether the wireless network is degrading the initiated communications services after a predetermined temporal period; receiving data indicative of the requested state information and testing the requested state information for differences; and, automatically smoothing the communications services using at least one of the communications devices if differences detected exceed a given threshold.

Brief Description of the Drawings

The present invention will now be described in connection with the following figures in which like reference numbers refer to like elements and wherein:

Fig. 1 is a schematic diagram illustrating a preferred embodiment of the system of the present invention;

Fig. 2 is a schematic diagram illustrating an alternative preferred embodiment of the system of the present invention;

5 Fig. 3 is a schematic diagram illustrating a preferred embodiment of the method of the present invention;

Fig. 4 is a flowchart or process diagram illustrating the synchronization process of a preferred embodiment of the present invention;

10 Fig. 5 is a flow chart or process diagram illustrating the synchronization process of an alternative preferred embodiment of the present invention;

Fig. 6 is a flowchart or process diagram illustrating the game mediation process of a preferred embodiment of the present invention;

Fig. 7 is a flowchart or process diagram illustrating the game mediation process of an alternative preferred embodiment of the present invention;

15 Fig. 8 is a flowchart or process diagram illustrating the game mediation process of an alternative preferred embodiment of the present invention;

Fig. 9 is a flowchart or process diagram illustrating the network mediation process of a preferred embodiment of the present invention; and

20 Fig. 10 is a flowchart or process diagram illustrating the network mediation process of an alternative preferred embodiment of the present invention.

Detailed Description of the Preferred Embodiments

According to an aspect of the present invention, there is provided a system and method for providing interactive services via a wireless communications network, controlling the state of an interactive application and controlling delivery of the interactive application to one or more users such as a gaming application.

It is to be understood that the figures and descriptions of the present invention have been simplified to illustrate elements that are relevant for a clear understanding of the present invention, while eliminating, for purposes of clarity, many other elements found in a typical telecommunications system and method. Those of ordinary skill in the art will recognize that other elements are desirable and/or required in order to implement the present invention. However, because such elements are well known in the art, and because they do not facilitate a better understanding of the present invention, a discussion of such elements is not provided herein.

According to an aspect of the present invention, market penetration of interactive wireless services may be achieved and reduced. According to an aspect of the present invention, the cost to the system operator of wireless game service may be reduced.

According to an aspect of the present invention, a degree to which interactive wireless services are network dependent may be reduced. According to an aspect of the present invention, a degree to which interactive wireless services are time of day

dependent may be reduced. According to an aspect of the present invention, an availability of interactive wireless services may be increased.

According to an aspect of the present invention, network capacity may be efficiently utilized. According to an aspect of the present invention, network capacity may be efficiently utilized for interactive wireless gaming applications. According to an aspect of the present invention, an interactive application may be adjusted to substantially match applicable data transfer requirements of the wireless network. According to an aspect of the present invention, a substantial amount of the software required to operate the interactive application may be maintained on a personal handset device as opposed to the network, for example. According to an aspect of the present invention, a substantial amount of the instructions required to operate the interactive application may be maintained on a personal handset device as opposed to the network, in order to reduce network traffic.

According to an aspect of the present invention, wireless transmissions between the network and the personal device may be adapted to reduce latency. According to an aspect of the present invention, a latency of the response of the interactive application may be limited. According to an aspect of the present invention, a reduced cost interactive service may be provided. According to an aspect of the present invention, a perceived speed of interactive use may be increased. According to an aspect of the present invention, differences in latency between users of the interactive service may be reduced, and a substantially consistent level of latency between users of the interactive

service may be achieved. According to an aspect of the present invention, an even playing field for the interactive services may be provided. According to an aspect of the present invention, differentials that may exist between users of the interactive service based upon differences in download or modem speed between the portable handheld devices may be at least partially mitigated. According to an aspect of the present invention, a cost effective way to deliver interactive services to end users may be provided. According to an aspect of the present invention, an interactive gaming community may be supported.

As illustrated in the accompanying diagrams and disclosed in the accompanying claims, according to an aspect of the present invention, a system may provide one or more wireless interactive applications to one or more users. According to an aspect of the present invention, a system may include: a wireless communication network; one or more servers cooperating with the network to deliver one or more interactive application(s) to the one or more users; and one or more wireless access devices, in communications with said network. The one or more wireless access devices may receive communication from the server to facilitate the users accessing the one or more wireless interactive applications using the wireless access device.

According to an aspect of the present invention, the system may include: a wireless communication network; an interactive application delivered over the wireless network to one or more users; one or more wireless access devices adapted to receive and render the interactive application to the user; control means for controlling the state

of the interactive application; and network mediation means for controlling delivery of the interactive application to the one or more users.

According to an aspect of the present invention, the system may include: a wireless communication network adapted for transmission of communications to facilitate the one or more interactive applications at less than the full frame rate of voice communications; and one or more servers, cooperating with the network to deliver one or more interactive application(s) to the one or more users. The system may also include one or more wireless access devices, in communication with the network. The one or more wireless access devices may receive communications from the server to facilitate the users accessing the one or more wireless interactive applications on the wireless access device. The one or more interactive applications may further include high resolution game applications featuring substantially high resolution graphics, and may reside on the wireless access device.

According to an aspect of the present invention, a method may include: initiating a request for wireless interactive services to the network; sending communications to the network to request the interactive application; compiling the request and communicating to a wireless access device software necessary to perform the one or more interactive applications; and initiating the interactive application(s). The method may include: communicating to the network one or more degrees of freedom of the interactive application; storing information about changes in state of one or more of the degrees of freedom caching; the information; communicating the cached

information to the server in order to efficiently utilize network resources (the wireless access device communicating signals reflecting the change of state of the interactive application); maintaining one or more interactive applications on the server; synchronizing the interactive applications among the users; and communicating updates to the one or more interactive applications until play is concluded or terminated.

It will be apparent to persons of ordinary skill in the art that modification and variations may be made in the present invention without departing from the scope or spirit of the invention. For example, one or more interactive applications according to the present invention may exhibit a range of latency values along a continuum, for example: less than about 30s; less than about 10s; less than about 1s; less than about 500ms; less than about 300ms; and/or less than about 200ms.

For example, the wireless access device according to the present invention may include a handheld device. The wireless access device may include an 8 bit microprocessor, exhibiting a clock speed of greater than about 4 MHz. The wireless access device may have a range of memory capability along a continuum, for example: greater than about 256Kb memory; greater than about 512Kb memory; greater than about 1Mb memory, greater than about 2Mb memory; greater than about 4Mb of memory; or greater than about 8Mb of memory.

The wireless access device according to the present invention may include a video display having a range of resolution along a continuum, for example: in excess of 160 x 144 pixels, or 240 x 160 pixels, and may include a black and white, monochrome,

or color display. The color display may be capable of rendering more than for example about 256 colors; 2,000 colors; 24,000 colors; 32,000 colors; or 64,000 colors or other values along a continuum.

5 The wireless access device may include a source of battery power sufficient to power the device for more than about 30 hours. The wireless access device may include a 16 bit microprocessor; a 32 bit microprocessor; and/or a 32 bit RISC microprocessor or any other suitable value. The microprocessor may have a clock speed of greater than about 8 MHz, and may have a clock speed of greater than 16 MHz or any other suitable value. Memory usable by the microprocessor may be external to the microprocessor. 10 In addition, the wireless access device may include VRAM and/or WRAM memory, for example.

15 The users of a system according to the present invention may be one or more users and may be up to eight or more simultaneous users. In addition, the system according to the present invention may conserve network resources based upon the application being delivered and utilized, such as by packing and ordering bits for example. Communications from a network to the wireless access device may occur at a full frame rate. Communications from the network to the wireless access device may occur at a half frame rate or other or other levels, more conservative of bandwidth, for example.

20 Furthermore, the wireless access device according to the present invention may cache information regarding the interactive application, fill data packets, and/or

dispatch communications to ensure efficient use of the network. In addition, an application feature according to the present invention may offer a user more than three degrees of freedom and may reside on the wireless access device, for example.

Thus, it is intended that the present invention include the variations and
5 modifications that may be used in conjunction with the invention, provided they come within the scope of the appended claims and their equivalents.

It is to be understood that both the foregoing description and the following
description are exemplary and explanatory only, and are not restrictive of the invention
as claimed. The accompanying drawings constitute a part of the specification, illustrate
10 certain embodiments of the invention, and together with this detailed description, serve to explain the principles of the present invention.

Reference will now be made in detail to a preferred embodiment of the method
and system of the present invention, an example of which is illustrated in the
accompanying drawings. A preferred embodiment of the present invention is shown in
15 Fig. 1 as interactive system 10. As shown in Fig. 1, the interactive system 10 includes:
a telecommunications network 100, interactive application 200 delivered over the
network 100 to one or more users; one or more wireless access devices 300 adapted to
receive and render the interactive application 200 to the user(s); game server 400; and
interface 900.

20 A preferred embodiment of the method of the present invention is depicted in
Figs. 3, 4, 5, and 8. As shown in Fig. 3, the method of the present invention preferably

includes: synchronizing 1000, controlling 2000, and mediating 3000 the interactive application 200 rendered to the at least one wireless access device 300.

An exemplary form of the synchronization process 1000 of the present invention is depicted in Fig. 4. The synchronization process 1000 may include: initiating the gaming session 1100, including initiating a connection between each of the wireless access devices 300 (clients) and the game server 400; synchronizing the clients 1200; synchronizing the server 1300; and facilitating the interactive application (gaming) session 1400. State of play may be synchronized between the various users of the interactive entertainment service. In addition, the game may be mediated and controlled to enhance the entertainment experience, while efficiently managing control of the interface between one or more wireless access devices of the users and the wireless communications network.

Fig. 5 depicts a synchronization process 1000 of an alternative form of the present invention. First, in step 1110, the user logs on to the system. The user then requests game play, in step 1120, from the game server 400. The interactive system 10 then seeks to locate other players, in step 1130, and retrieves player information and past history about the players whom it has located in step 1140. Alternatively, the player information and past history may be retrieved after players are selected for the current gaming session. Next, the interactive system 10 retrieves game information, in step 1150. At this point in the process, the game has been initiated, as shown in step 1410, and the users are ready to begin play.

Game play may proceed, subject to the synchronization process 1000 of the present invention. As shown in Fig. 5, prior to initiating game play, the system may check to insure synchronization between all users 1200. Prior to initiating game play, state information may be supplied to synchronization check timer 1310. The synchronization check timer 1310 cooperates with the game timer to determine whether or not the system should confirm synchronization to any users with the game at that point in time. If the game timer has not yet reached the point at which synchronization is called for, the synchronization timer 1310 delivers the users to game play 1420.

As shown in Fig. 5, game play may proceed until the game timer equals the synchronization timer 1310. At that point, the system requests state information from all users relative to game information 1320. The users deliver state information from each of the wireless access devices 300 to the master game server 400, in step 1330, and the master server tests whether there are any differences in the state of play 1340. If there are insubstantial differences in the state of play 1340 between the user(s) and the game, the system delivers the user(s) back to the game to continue play 1420.

If there are differences in the state of play between the user(s) and/or the master server, the synchronization process 1000 of the present invention preferably determines and transmits the required adjustments to the affected device in order to synchronize all state machines, as shown in step 1350. The devices then receive the new state information in step 1230.

If desired, the client applications may initiate an algorithm to adjust the state of play 1240. The system then determines whether or not the state change requires smoothing in order to provide a high quality interactive experience for the user, as shown in step 1210. If smoothing is desired, the system adjusts the state 1250 and returns the users to game play in step 1420. If smoothing is required, the system initiates a smoothing algorithm, as shown in step 1220, snapping the users to the new state. The state is adjusted in step 1250 and the users proceed with play, as shown in step 1420.

Figs. 6, 7 and 8 depict alternative forms of the operation of the control means 600 of the present invention. The control means 600 may provide management of the real time state of game play and facilitate the game mediation process 2000 of the present invention. As shown in Fig. 6, the game mediation process 2000 may include: initiating the gaming session 2100; matching skill levels of players 2200; matching and accommodating device capabilities 2300; facilitating game play 2400; and terminating the gaming session 2500.

As shown in Figs. 7 and 8, the initiation step 2100 of the control process 2000 may further include: logging onto the system 2110; requesting game play 2120; and locating other potential players 2130.

As shown in Fig. 8, the step of matching skill levels 2200, which enables the system to evaluate the players' respective skill levels and determine whether or not they wish to proceed, preferably may include: retrieving player information and past history

2210; retrieving game information 2220; determining the skill level of the respective potential players 2230; notifying each of the prospective players of the skill levels of the other potential players 2240; and requesting each player if they wish to continue 2250. If the players wish to continue, they may proceed to the step of matching an accommodating device capabilities 2300, for evaluating and resolving any differences between the user's respective access devices and the network. If the player(s) do(es) not wish to continue, the system may search for other players 2260 with similar skill levels. Once located, the player may be returned to the step of locating other players 1130.

If the player wishes to continue in spite of differences in skill level, as determined in step 2266, the system may evaluate the capabilities of each users connection and device in step 2305. The differences in devices are may be determined in step 2311. If there are differences in the devices, the process may proceed to accommodate the device differences 2300.

Fig. 8 illustrates further steps of accommodating device differences 2300. This process of evaluating and resolving any differences between the users' respective connections and device of the game mediation process 2000 of the present invention may include: querying the respective devices regarding the capabilities of their processors 2366; querying the respective devices regarding signal strength 2370; querying the respective devices regarding their video capabilities 2375; querying the respective devices about latency 2380; and evaluating the capabilities of each users' device 2305.

Any differences between the devices and connections may be determined. If there are differences between the devices, as determined in step 2310, the process may then compare the device characteristics in step 2330. The process then determines the lowest common capability set, as shown in step 2335 and issues command applications, as shown in step 2340, to enable only the capability set that has been determined. The process proceeds to determine any differences between each users' connection over the network 100, as shown in step 2345. The process may further include running a ping test to determine connection differences, as shown in step 2350. The process may continue by adjusting the game server parameters to communicate with the devices according to their connection(s), as shown in step 2355, and, then initiating game play in step 2410. If there are insubstantial differences between connections, the method may proceed instead directly to step 2410 and the initiation of game play.

Fig. 7 depicts an alternative form of the control process 2000, and in particular, the step 2300 of accommodating device capabilities according to the present invention. As shown in Fig. 7, the accommodating device capabilities 2300 process of the present invention may further include: determining one or more players' skill level(s) from past performance or other criteria 2395; evaluating the capabilities of each users' connection and device 2305; and adjusting the game server 400 to accommodate for device and connection differences 2390.

Fig. 9 depicts a form of the mediation process 3000 and in particular the network mediation process for matching players of the present invention. As shown in

Fig. 9, the network mediation process 3000 of the present invention may include: initiating an interactive session 3100; locating potential players 3200; mediating the application 3300, facilitating game play 3400; and terminating the gaming session 3600.

An alternative form of the mediation process 3000 of the present invention is shown in Fig. 10. The step of initiating game play 3100 may further include: logging on to the system 3110; requesting game play 3120; and locating other players 3130. The step of locating players 3200 may further include: retrieving player information and past history 3210; retrieving game information 3220; retrieving device information 3230; and determining whether or not the device can provide location information 3240.

If the device or network does not include means to determine and provide to the network or to other users the location of the wireless access device 300, the process may proceed with enabling game play 3400. The step of enabling game play may further include: setting up client-server communications 3406; initiating game play 3410; enabling game play 3420; and ending the game play session 3430.

To the extent the device is able to provide location information, the process may instead proceeds to the step of locating and resolving peer-to-peer communications 3300. The step of evaluating and resolving peer-to-peer communications may further include: retrieving location information from the respective devices 3310; determining whether or not the devices are close enough to initiate peer-to-peer play 3320 (and if they are not, proceeding with the step of game play 3400 as described above); determining whether the devices are capable of peer-to-peer play 3330 (and if they are

not, proceeding with the step of enabling game play 3400 described above); and setting up peer-to-peer communications 3340.

Once peer-to-peer communications are established, as shown in step 3340, the process may proceed with initiating game play 3410. It may not be necessary to set up client-server communication, as shown in step 3405, in a peer-to-peer communication environment.

As shown in Fig. 10, the step of terminating a game session may include: determining whether or not the session was a peer-to-peer communication 3510; uploading game and player detail 3530 to the server(s) 400; and ending the session 3540. If the session was peer-to-peer, this process further comprises the client reestablishing network connection to the server, as shown in step 3520; uploading game and player detail to the server(s), as shown in step 3530; and ending the session in step 3540. If the session was not a peer-to-peer session, the process proceeds with the steps of uploading the game and player detail to the server 3630 and ending the session 3540.

It will be apparent to persons of ordinary skill that various modifications and variations may be made in the process of the present invention and, in particular, in the synchronization, control, and mediation processes of the invention, without departing from the spirit of the invention. For example, the management and interaction of the presentation, action, and control functionality can each reside at various locations in the system. The system communicates and coordinates these functions between the various users. The hardware and software used to perform these functions, may reside at the

wireless access device 200, network 100, or the game server 400, or any combination of those locations. The different functional levels must communicate effectively with one another. The system is adapted to enable them to communicate and cooperate appropriately to achieve the objects of the present invention. Thus, it is intended that the variations and modifications be considered part of the invention, provided they come within the scope of the appended claims and their equivalents.

As shown in Fig. 1, a preferred embodiment of the interactive system 10 of the present invention includes: telecommunications network 100; interactive application 200 delivered over the network 100 to one or more users; one or more user wireless access devices 300 adapted to receive and render the interactive application 200 to the user; game server 400; and an interface 900.

According to an aspect of the present invention and as shown in Fig. 2, telecommunications network 100 can take the form of a wireless communications network. Other suitable embodiments of the telecommunications network 100 of the present invention, include, but are not limited to: Plain Old Telephone Service (POTS); Public Switched Telephone Network (PSTN); Integrated Services Digital Network (ISDN); Asymmetric Digital Subscriber Lines (ASDL); any of various other types of Digital Subscriber Lines (xDSL); Public Land Mobile Network (PLMN); the Internet; cellular; Global System Mobile (GSM); General Packet Radio Services (GPRS); Infrared Data Association (IrDA); Cellular Digital Packet Data (CDPD); Enhanced Data Rates for Global (or GSM) Evolution (EDGE); Universal Mobile Telecommunications

System (UMTS), Ricochet proprietary wireless packet network; wireless local loop (WLL); Wireless Local Area Network (WLAN); 802.11; infrared; Bluetooth; Wide Area Network (WAN); Local Area Network (LAN); Optical; Line of Sight; satellite-based systems; Cable; User Datagram Protocol (UDP); SMR (walkie talkies);
5 any portion of the unlicensed spectrum; wireline networks; and/or any other suitable telecommunications network 100. Any suitable communications network is considered to be within the scope of the present invention, provided it can render the interactive application 200 to the user, as described herein.

The interactive system 10 of the present invention may be adapted for use in
10 conjunction with a wireless communications network 100 that is data capable, as opposed to a first generation cellular (voice only) network. The wireless network 100 may be based upon PCS, TDMA, CDMA, CDPD, CDMAone, or any other suitable technology(ies) or standard(s) that are data capable, for example.

As shown in Fig. 2, wireless communications network 100 may further include
15 one or more base station(s) 110, one or more base station controller(s) (BSC) 120, and one or more mobile switching center(s) (MSC) 130. As will be apparent to one of ordinary skill in the art, each base station 110 includes a transceiver (not shown) capable of transmitting signals to and receiving signals from the wireless access devices 300. In addition, each base station 110 is connected through the base station controller
20 120 to the mobile switching center 130.

The mobile switching center 130 may cooperate with the game server 400 through the Interworking Function ("IWF") 150. The IWF 150 may be connected to the Internet 140. As will be apparent to those of ordinary skill in the art, the IWF 150 may include the necessary equipment and conversion algorithms to permit seamless communication between the mobile switching center 130 and the mobile game server 400, despite potentially dissimilar protocols supporting each of those components. Other embodiments of the IWF 150, such as, for example, a PCE node, a Packet Data Serving Node (PDSN), or any other node of similar functionality are considered within the scope of the present invention.

The mobile switching center 130 may be linked to the public switched telephone network (PSTN) 160. Further, in cooperation with the mobile switching center 130, the interactive system 10 may include a home location register (HLR) 170 for identifying and/or verifying subscribers on the interactive system 10. As will be apparent to those of ordinary skill in the art, the wireless communications network 100 may be adapted to allow communication between the wireless access devices 300 and the game server 400.

As shown in Fig. 2, the network 100 may further include message means 800 for providing communication between users. Message functions, such as SMS (Short Message Service), Text, Voice, and chat, may be provided in conjunction with the present invention in a manner known.

According to an aspect of the present invention, the wireless communications network 100 may be adapted to efficiently manage the air interface. The data transfer

rates of the present invention may be adapted to provide an enriched, realistic interactive application, such as a game, while minimizing the amount of bandwidth that is dedicated to providing the interactive application 200. For example, the interactive system 10 may minimize the number of degrees of freedom managed over the wireless network 100 by providing predefined subroutines on the wireless access device 300.

According to an aspect of the present invention, spawned degree of freedom information may be managed, such as, for example, projectile information. In an interactive application where a projectile, such as a missile, rope, or arrow may be launched, the system may transmit information and track movement of two discrete objects (the projectile and the image launching it).

The trajectory of the projectile may be calculated at the wireless access device 300, based on formulae or other data to depict movement of the projectile. The calculations, and the formulae required to make the calculations, may be game specific and part of the interactive application 200 downloaded to the wireless access device 300. For example, when the interactive application 200 requires a ball to be thrown, the wireless access device 300 of the present invention may locally evaluate the trajectory and depict the path that the ball will take, rather than sending and receiving multiple instructions over the network depicting each stage of movement of the ball. This prevents the present invention from tying up valuable network capacity.

The wireless access device 300 may receive update information from the game server 400, based on any conditions that would alter the trajectory that is calculated at

the wireless access device 300. These may include, for example, shifts in wind direction and magnitude, or other forces. The use of the network's air interface remains efficient because the interactive system 10 preferably transmits only the minimum necessary information, in contrast to prior known systems that transmit at a full frame rate, regardless of the availability of or need for data for transmission.

According to an aspect of the present invention, network resources are efficiently used by providing a reduced amount of information necessary at each point to enable the wireless access device 300 to render the interactive application 200. A number of methods may be used to reduce the amount of information necessary to enable the interactive application. It will be apparent to persons of ordinary skill in the art that various modifications and variations may be made and the manner in which the air traffic required to produce the interactive application may be reduced, without departing from the scope of the invention as claimed. For example, the amount of information transmitted over the wireless network 100 pertaining to the degrees of freedom of the interactive application 200 may be reduced. This function may be accomplished by any number of alternative and/or complimentary means. The instruction set may be layered. Sets of instructions may be grouped together in a logical fashion in order to reduce the amount of air traffic necessary to actuate the movement of a game piece. For example, the movement of a character that is running may be broken into several series of actions and instructions layered to depict groups of those actions. Arm movement may be depicted in one series of instructions; leg movement could be

depicted in another; and movement of the character horizontally and/or vertically could be depicted in yet other layers of instructions.

Similarly, according to an aspect of the present invention, multiple sets of instructions may be collapsed into a single instructions set, set(s) of codes, or subroutine(s). Although this may require creating a number of codes that represent the various actions the character could maintain, it offers the potential for dramatically reducing the amount of air interface traffic required to actuate a game, for example. According to an aspect of the present invention, many actions involved in the game may be reduced to a single subroutine. Activities such as running, jumping, throwing and crawling may be reduced to a single or reduced instruction set so that when the single or reduced instruction set is transmitted over the wireless network 100, the character performs a series of actions corresponding to that activity.

The present invention may provide an enriched interactive gaming experience on a least cost basis. This may be accomplished by minimizing traffic over the air interface and more efficiently managing network resources so as to enable a system operator to reduce costs.

According to an aspect of the present invention, interactive application 200 may include: an application 210; a device adaptation means 220; a communication means 230; and a mediation means 240, based on various criteria relating to the interaction of the users of the interactive entertainment service.

5 The interactive application 200 may include, without limitation, any one or more of the following: games; entertainment services; stock quotations; message boards; purchasing; advertising; news services; bill payment; instant messaging; email; location-based information and services; and any other interactive application. It will be apparent to persons of ordinary skill in the art that any of various applications may be adapted to be used with the present invention. Thus, it is intended that the present invention include all of the various applications that may be adapted to be used with the invention, provided they come within the scope of the appended claims and their equivalents.

10 The interactive application 200 may further be adapted to cooperate with certain features of the wireless network 100 or of the wireless access device 300. According to an aspect of the present invention, wireless access device 300 may include: controls 310, peripherals 320, and a user interface 330. The interactive application 200 may be adapted depending on the platform, or the particular hardware or software being employed on the wireless access device 300. Similarly, the interactive application 200 may be adapted depending on physical parameters, such as battery life for the form factor of the wireless access device 300.

20 The communications means 230 of the interactive application 200 of the present invention may include one or more of: voice; physical feedback; text; video; images; attachments; or location-based information. Preferably, the present invention may be further adapted to provide, as applicable: voice mail; store and forward features; hand

messaging features; the ability to deliver unique messages; email; instant messaging; audio; video; images; text; electronic cards; music; advertising; peer-to-peer communications; geographic information; directions; and information on any other subject.

5 Physical feedback embodiments of the communication means 230 of the interactive application 200 of the present invention may be adapted to provide sensory input to a user, by way of example one or more of: vibration, such as through the use of a rumble pack; heat; pressure; sound; sight, through enhanced visual effects; smell; touch; and any other sensation.

10 Control means 600 of the game server 400 of the present invention may further include a game mediation means 620 for mediating the interactive application 200 of the present invention based on various parameters regarding the level of play and the interaction of the users. The game mediation means 620 may be embodied in the interactive application 200 as a software application and/or in an algorithm that resides
15 on one or more servers in the interactive system 10.

 As embodied herein, the wireless access device 300 may take the form of any suitable user device adapted to interface with the communications network 100 to provide a multiplayer, interactive communications application such as a game. According to an aspect of the present invention, wireless access device 300 may include
20 a wireless communications device such as a mobile phone. According to an aspect of the present invention, wireless access device 300 may include one or more of: a

personal digital assistant (PDA); a pager; a wireless game controller; and/or an email device.

Wireless access device 300 may include one or more peripherals 320 including by way of example: headphones; earphones; cables; joysticks; paddles; cameras; microphones; speakers and external keypads. Wireless access device 300 may be adapted to run on any platform suitable for providing interactive application 200 and the desired functionality of the interactive system 10. The platform may include any number of operating systems known in the art, such as, for example, Palm, Windows, Symbian, Java, Mac, or any other operating system capable of supporting the functionality of the interactive system 10.

According to an aspect of the present invention, wireless access device 300 may be adapted to provide voice-over-packet services. These services may include interactive group communications service, such as voice chat applications like the QChat application developed by Qualcomm. QChat serves as a wireless extension of Internet chat and instant messaging services. These services may be employed by minimizing the packet frame size used for the communication during times of network congestion or any other time determined by the carrier. Voice-over-packet may be limited to half-rate frames to minimize the amount of data sent at the expense of voice quality, for example.

As shown in Figs. 1 and 2, the present invention may include the game server 400. The game server 400 may enable a user to play an interactive entertainment

application 210 and further include means for downloading, purchasing, selling, and billing the user for the application 210. The game server 400 may include any server with a network interface adapted for use in conjunction with the communications network 100, the interactive application 200, and the wireless access device 300 of the present invention 10. The game server 400 may include a Sun Metra Platform. Applications, e.g., games, 210 may be provided, e.g., sold, in client (single player) and server (multi-player) versions. Game server 400 may be adapted to provide games 210 and other applications over a wireless communications network.

Game server 400 may further include: a synchronization means 600 for synchronizing the state of play between the users and the network 100; a control means 600 for controlling the state of the interactive application; and a network mediation means 700 for controlling delivery of the interactive application 200 to the one or more users. Game server 400 may include one or more servers. The synchronization means 500, the control means 600, and the network mediation means 700 may reside on the same or different server(s). As shown in Fig. 2, and will be apparent to those of ordinary skill in the art, any of a number of configurations of the game server 400 would allow for communication with the interactive system 10 of the present invention. For example, the functions of the game and player databases 410 and 420, and of the synchronization means 500, the control means 600, and the mediation means 700 may be embodied in a single or multiple structures. Alternatively the game server 400 could

be housed within or separate from the network 100 or any of its components. The interface(s) 900 may be adapted accordingly.

The game server 400 may further include a game database 410 for storing various game software and/or other interactive applications, and a player profile database 420 for storing the profiles of subscribers to the interactive system 10. The hardware employed may be of a type known in the art for data storage and retrieval functions. Similarly, the connections between the components of the game server 400, the synchronization means 500, the control means 600, and the mediation means 700, may be high speed, router-server connections, of a type well known in the art.

According to an aspect of the present invention, game server 400 may further include synchronization means 500 for synchronizing the transmission and display of the interactive application 200. Synchronization means 500 may be embodied in a software application and/or an algorithm that resides on the game server 400. The synchronization means 500 may be adapted to enable the user to experience a robust and jitter-free gaming environment. The synchronization means 500 may be used to identify when a player is in a game state that is not the same as the game state of the server, or of the other players, for example. Game server 400 may further calculates a correct game state. Synchronization means 500 may be adapted to cooperate with the game server 400, which provides information about the state the player should be in. Synchronization means 600 may order the interactive application 200 to make the appropriate changes to bring the players into synchronization.

Gaming applications 210 may be subject to creep or wander problems. It is preferable, therefore, to maintain synchronization between each wireless access device 300 and the network 100, relative to the state of play of the interactive application 200. That is, each player in the interactive session should see on their display the same state of the game as each of the other players. This synchronization of the game state may be accomplished in the present invention through any of a number of mechanisms including, without limitation, providing separate synchronization means 500 for synchronizing the systems; monitoring the manner in which the system is mediated; or imposing separate software systems or control features to limit or eliminate creep and wander.

According to an aspect of the present invention, wireless access device 300 can transmit its overall state information to the synchronization means 500 at a given interval. The timing and length of the interval may vary depending on the interactive application (game) being played, its complexity, and the number of degrees of freedom involved, for example. The synchronization means 500 may then determine, based on the state information it receives from all of the wireless access devices 300 in the particular interactive session, what actions, if any, need to be taken.

The control means 600 of the present invention may be adapted to manage the real time state of play of the interactive application 200; maintain overall synchronization of players during the game; ensure proper distribution of information to and from the players; and route information to the appropriate players as required.

Control means 600 may further be adapted to determine or place users into different networks as appropriate for game play. This function may be accomplished through cooperation with and based on information supplied by the mediation means 700, as well as by the users themselves, for example.

Control means 600 may include a server of the type well known in the art. Control means 600 may further include a generic processor operating at a fast clock rate, such as a Sun SPARC work station. The processor may be a single, dual, multiple, distributed, or multithreading processor.

According to an aspect of the present invention, game server 400 may operate at the router frame rate and provide handicapping, based upon information supplied by users and or the users' profile(s) from player database 420, for example. Control means 600 may also provide error correction functions.

Control means 600 may further include game mediation means 620. When users of different skill levels interact in an application, the game mediation means 620 may define the state of play in order to achieve a level playing experience. Because the game mediation means 620 has access to each player's profile in the player database 420, the game mediation means 620 has access to information such as, for example, how well the player has performed in a particular game in the past, and how often they have played a particular game. Using this information, the game mediation means 620 may assign a rating to a player for a particular game. Individual game ranking may be stored in a user's profile stored in the player database 420. The game mediation means

620 may allow players to enter into the interactive session who are within a given rating for the game being played.

Game mediation means 620 may notify players in the interactive session that one player may be more (or less) skilled than another. Game mediation means 620 may mediate the interactive application 200 based on features of the wireless access devices 300 in a particular interactive session and/or other factors relevant to a player's gaming experience. Game mediation means 620 may further include one or more of the following features: display; processor; user preference; language; file support; identity of the user; other features or characteristics of the user; the access device being employed; the control means being used; bandwidth requirements; and ping rate. Game mediation means 620 may be in communication with a wireless access device 300 prior to the start of a gaming session.

Control means 600 may perform the processes illustrated in Figs. 5, 6, and 7. After the user has logged onto the system and requested game play, the interactive system 10 may locate other players who wish to participate in the interactive gaming session. Control means 600 may retrieve player information from the player database 420 and game information from the game database 410. Control means 600 may retrieve information about each wireless access device 300 and its connection over the wireless network 100. Control means 600 may determine a skill level of the players who have indicated that they wish to join the gaming session.

The process of determining a player's skill level may include determining a player's past performance at playing this particular game and ranking the players based on past performance. The ranking system used by the control means 600 may include scalable nomenclature, which may be as simple as a numerical ranking from 1 (for novice) to 5 (for expert), or may include any nomenclature adapted to application 200. Control means 600 may communicate a player's skill level to other players. Each user may then be prompted on their wireless access device 300 to indicate whether they wish to continue playing. If a player chooses to opt out of the gaming session, the system may be adapted to locate replacement players.

After the system establishes the players, control means 600 may evaluate the capabilities of each of the users based on their wireless access device 300 and their connection to the wireless communications network 100, as discussed above. Control means 600 may then compensates for skill, device, and connection differences as shown in Figs. 5, 6, and 7.

Control means 600 may further be adapted to provide an enriched data environment, without sacrificing the efficient management of the air interface. Each wireless access device 300 may have high resolution, and may be black and white, monochrome, or color. The present invention may further include a color management means 350 for managing the delivery of color to the wireless access device 300.

Interlacing techniques such as those known in the broadcast industry may be used.

When color is used, the interactive system 10 may provide an efficient, yet enriched, data environment by defining color as a degree of freedom.

For example, the facial color of a character in the interactive application 200 may be defined by one degree of freedom with three states (e.g., orange, red, and purple). The face may be defined in the (client) wireless access device 300 by transmitting only the state of the facial color over the air interface. When the character's face becomes bruised, for example, the interactive system 10 may transmit "purple" state information only. In addition, in a manner similar to that by which the trajectory of a projectile is calculated, the present invention further reduces air link traffic by calculating the state information at the wireless access device 300 instead of transmitting the information over the network. For example, if events x and y occur, the wireless access device 300 may be adapted to display a color state z.

Control means 600 of the present invention may be adapted to use user profiles stored on the player database 420 for providing a personalized, interactive application. For example, the user profile preferably comprises information about a user's experience level, enabling the interactive system 10 to supplement the interactive application with personalized messages, such as prompts, game hints, and help files. The user profile may further include: the genre(s) of application(s) in which the user is interested, a user's skill rank for a particular game, training files to allow a user to improve his/her skill level at a particular game, and messages aimed at taunting the user during play. The network infrastructure for providing the user profile functionality to

the control means 600 of the present invention preferably further comprises the subject matter described in U.S. Provisional Patent Application Serial No. 60/276,056 entitled "METHOD AND SYSTEM FOR CONTENT DISTRIBUTION OVER A WIRELESS COMMUNICATIONS SYSTEM" filed March 16, 2001, which is incorporated herein
5 by reference as if fully set forth herein.

Control means 600 may further be adapted to monitor and/or limit user's access to particular interactive applications. For example, the control means 600 may prevent a user from accessing an interactive application that the user's wireless access device 300 is not capable of supporting (e.g., lack of graphics capability, lack of processing
10 speed, software version incompatibility), or may limit a user's access to a particular gaming application if the user has not attained, or maintained, a certain skill level (too skilled or not skilled enough). In this manner the control means 600 may be adapted to sort stored user profiles and match users based on predefined ranges of skill, equipment specifications, and/or other attributes. The control means 600 may further be adapted to
15 allow users to request to play other users that may be outside these ranges. In these instances, the control means 600 may preferably notify the users of the (dis)advantages of the other player(s). Control means 600 may further include a handicapping mechanism for leveling the playing field.

Control means 600 may be adapted to recognize the location of a wireless access
20 device 300. Control means 600 may further include software that recognizes the GPS and/or ANI address information of the user or the wireless access device 300. Location

information may be gathered and transmitted by the wireless access device 300, using GPS and location software and/or estimation methods of the type known in the art. For example, location information may be estimated by the interactive system 10 based on any one or more of prior known methods, comprising one or more of: round trip signal delay; triangulation; received power; and the cell site location with which the wireless access device 300 is in communication.

Control means 600 may be adapted to provide administration services. The control means 600 may store directories of users of the interactive system 10, allocated into certain affinity groups, or interactive communities. According to an aspect of the present invention, administrative service means and interactive community functionality, as disclosed in U.S. Patent Application Serial No. 09/833,656, entitled "METHOD AND SYSTEM TO FACILITATE INTERACTION BETWEEN AND CONTENT DELIVERY TO USERS OF A WIRELESS COMMUNICATIONS NETWORK," filed April 13, 2001, which is incorporated herein by reference as if fully set forth herein, may be provided.

Control means 600 may include a game management means 610 for managing a particular gaming interactive application. The game management means 610 may be adapted to alter the overall states of certain global degrees of freedom. For example, the game management means 610 may adjust the conditions of the field of play for a gaming application by providing instructions to the wireless access device 300 for rain, snow, wind, or any other change of field or state, of play conditions. The instructions

preferably may be provided to the wireless access device 300 in an arbitrary fashion, or according to a schedule stored in the control means 600, for example. According to an aspect of the present invention, the game management means 610 may include an algorithm or software means designed for a specific gaming application 200.

5 According to an aspect of the present invention, the game management means 610 may be performed through human intervention at the administrator level of the wireless communication network.

10 Control means 600 may further include error correction means 630 for minimizing transmission errors during delivery of the interactive application. The error correction means 630 may include any of the known error correction techniques, for example: block coding methods; convolutional coding methods; or any other error correction methods known by those of ordinary skill in the art.

15 It will be apparent to persons of ordinary skill in the art that numerous variations may be made in the present invention, without departing from the scope and spirit of the present invention. According to an aspect of the present invention, users may be billed according to Assignee's Cricket™ business model. Users may be billed based upon: a flat rate with unlimited use; on a pre-paid basis; based on minutes of use; on a pay per play basis; and/or any combination of known billing methods. In addition, the provision of the interactive application 200 to the user may be sponsored, such that the
20 user receives a discounted or subsidized rate, in return for listening to personalized

advertisements before, during, and/or after the interactive session, for example. Control means 600 may be adapted to manage billing functions.

Control means 600 may further include means to maintain a persistent state of play. For example, a user may end an interactive gaming session and the control means 600 store the session so that the user may resume the session at a later time. Alternatively, if the user ends a gaming session that included multiple players, the control means 600 may be adapted to store the session so that it may be resumed by all or certain of the players at a later time.

Control means 600 may further include back up, fail over, and/or redundancy systems to prevent data, such as a user profile and/or stored gaming session information, from being lost. Control means 600 may include known systems and methods, such as, for example, RAID storage, active mirroring of information, hear-beat signaling, load sharing, and/or any other methods known by those of ordinary skill in the art.

According to an aspect of the present invention, network mediation means 700 of the present invention may be adapted to match players for multi-player gaming. The network mediation means 700 may employ user profile information to establish the application 210 adapting gaming parameters to control: latency; degrees of freedom; skill levels; and device and connection types, for example. Network mediation means 700 may employ means similar to those used by the control means 600, however,

network mediation means 700 may need not run as close to real time as the control means 600.

Network mediation means 700 may mediate communications based upon specifications of each wireless access device 300, the interactive application 200, location of the user, and user profiles stored by the control means 600. Once it is determined that peer-to-peer communications are possible for a particular interactive session, network mediation means 700 may direct wireless access devices 300 to engage in a peer-to-peer interactive session. During a peer-to-peer interactive session, a wireless access device 300 may download any necessary information from the interactive system 10, and send limited information to the system 10 to maintain a proper level of knowledge required to provide an enhanced interactive experience. This information may include, for example, final scores, standings, and/or any other game related statistics that may provide the system with better understanding of the user and their experience. In addition, information may be sent from the network to the wireless access device 300, such as, for example, personalized messages and/or advertisements that are not resident on the device.

Other than the limited information sent to or from the wireless access device 300 during peer-to-peer mode, the wireless access devices 300 may communicate directly with each other the necessary information to maintain the game. This advantageously may reduce the amount of information that is transmitted across the wireless network

100 and reduces the operator's service costs without infringing on the user's playing experience.

The network mediation means 700 may be embodied in a software application and/or algorithm that resides on one or more servers in the interactive system 10. The network mediation means 700 may deliver the interactive application through a client-server environment over the wireless network 100. Network mediation means 700 may deliver the interactive application in a peer-to-peer environment independent of the wireless network 100. Network mediation means 700 may deliver the interactive application in a hybrid environment that incorporates a client-server environment in conjunction with an independent peer-to-peer environment.

Delivery of the interactive application by the network mediation means 700 may be based on many factors. Network mediation means 700 may take into account a spectral efficiency of the wireless network 100. For a particular interactive application session at a given time, the higher the spectral efficiency of the wireless network 100, the more of the interactive application that can reside on the server in the interactive system 10, for example. In contrast, when spectral efficiency is low, the network mediation means 700 may send more of, or the entire, interactive application to the user's wireless access device (at low network usage times, for example) so that the application may be used in a peer-to-peer or hybrid environment.

Mediation and delivery of an interactive application may depend on a value of the interactive application itself and the corresponding security measures appropriate to

protect the interactive application 200. For example, a proprietary video game that is valuable to the system operator may be stored substantially on the server and not be downloaded substantially to the (client) wireless access device 300. Less valuable applications or games may be distributed substantially or completely to the client devices in order to reduce air traffic and conserve network resources.

According to an aspect of the present invention, service may be rendered on a hybrid basis. In a hybrid scenario, structures, functions, and steps involved are substantially the same. If the interactive system 10 determines that it is desirable to provide some degree of peer-to-peer play, it may be adapted to do so. Synchronization information may be passed from the devices running peer-to-peer to the network. The system may also receive any changes required to maintain synchronization from the network. In the event that some devices are on alternate network types (i.e., 802.11), synchronization commands may be sent to the devices over that alternative network. Other game commands may be sent through a selected means (i.e., peer-to-peer). Thus, the system is adapted to provide efficient air link utilization.

The present invention may also include interfaces 900, for enabling communication between the various components of the invention for example. Interface connections 900 between the wireless network 100 and the game server 400 may be accomplished over any one or more of the interface links 900 shown in Fig. 2, for example. For example, a BSC 120 and/or MSC 130 may be connected to game server 400 over an "L Interface" 910 (Standard IS-658, which is incorporated herein by

reference) in a manner conventional in the art. Similarly, IWF 150 may be connected to the game server 400, the control means 600, and/or the mediation means 700 over TCP, IP, or Mobile IP protocols 910 in a manner known in the art. TCP, IP, and/or Mobile IP protocols are promulgated by standards setting organizations such as the IETF, which standards are well known in the art and are incorporated herein by reference. Other interface protocols, such as WAP (Wireless Application Protocol), CPDP, Mobitex, DataTac, i-Mode, or other protocols may be adapted to the present invention.

Various equipment manufacturers have implemented the standards in a manner that is adapted to their equipment. Lucent, Nokia, Ericsson, and other equipment manufacturers have each adapted the interface standards to their particular equipment and applications. Interfaces 900 may be adapted to implementation of the standards by the manufacturer of the equipment being employed.

According to an aspect of the present invention, interface 900 between the user access device 300 and the network 100 may be of a type known in the art of wireless communications services. Network 100 may be adapted to send variable length, rather than full length packets as is conventional in the art prior to the present invention. Packet transmission may be controlled to override the full length packet filler. Standard bin sizes (full, half, quarter, eighth) may be used and the transmission rate of the packets fixed, although these variables may also be adapted to improve the efficiency of use of the air interface. A manner in which bits are packed within frames may be forced to improve the efficiency of use of the air interface.

Interface connections between various of the components of the game server 400, and in particular, the game database 410, the user database 420, the synchronization means 590, the control means 600, and the mediation means 700 may be high speed router protocol connections of the type well known in the art.

5 Wireless network 100 may further include a plurality of "information service stations," or sub-networks, which may be located at various locations, such as, convenience stores, gas stations, and shopping malls, where a user may make a high speed or broadband connection with the wireless network 100 and receive updates relating to the interactive application 200 being used. Subnetworks may be adapted to have their own characteristics in addition to the characteristics of the master wireless network 100. For example, a user in a specific sub-network, such as, for example, a shopping mall, may receive information, as part of the interactive application 200, about stores located within the mall. A user may be notified about other users/players that are in the sub-network that the user may want to join in the interactive session. Finding potential players proximate (discussed below) to a particular user would enable the network mediation means 700 to join the players, at least in part, in a peer-to-peer environment, which allows for more efficient use of the network resources and enables more real-time interactive play. Sub-networks may offer lower cost service than the wireless network 100.

20 The delivery of the interactive application 200 by the network mediation means 700 may further be based on the proximity of the various users to one another. For

example, if multiple users are all located in close proximity to one another, for example, in the range of about 10 meters to about 100 meters, the network mediation means 700 may deliver the interactive applications to the user access devices 300 and enable their interactive session to occur in a peer-to-peer environment.

5 The system and method of the present invention may be fully compatible and usable in conjunction with PC based games, as well as Internet applications, and TV-based games. A service employing the system and method of the present invention may be offered as a flat rate offering in conjunction with services such as Assignee's Cricket™ wireless communications service. Such services may be offered on a prepaid
10 billing service for game purchase.

 Numerous other variations and modification will be apparent to persons of ordinary skill that will facilitate the delivery of wireless interactive applications, at high level of graphic quality, while more efficiently using network bandwidth and resources than prior known systems and methods. Thus, it is intended that the present invention
15 include the variations and modification that may be used in conjunction with them, provided they come within the scope of the appended claims and their equivalents.